COUPLED FINITE ELEMENT AND MESH-FREE SIMULATION OF CRASHWORTHINESS AND MANUFACTURING PROBLEMS

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The finite element method (FEM) has been used extensively in the assessment of vehicle designs. It is a method well developed and capable of solving various structural problems successfully. However, when dealing with severe shape changes that are typical in crashworthiness and manufacturing problems, this method can have deteriorated accuracy due to excessive mesh distortion. To overcome this mesh-related difficulty, various meshfree methods have been developed over the past few years. However, these methods generally require higher computational cost in terms of time and memory than the FEM, which greatly limits their applications. To combine the merits of the FEM and the meshfree method, a coupled FE/Meshfree method has been developed in LS-DYNA for the general dynamic explicit analysis in solids and shells [1, 2].

This paper first studies the applications of this coupled method in the analysis of crashworthiness problems, where foam materials are used commonly in deformable barriers and in bumper systems of modern automobiles for its energy absorbing capabilities. Extreme deformation that occurs after 80% compression can cause severe mesh distortion, and constantly results in premature job terminations due to negative volume. Also, the applications of this coupled method in two challenging manufacturing problems, a self-piercing riveting (SPR) and a deep cup drawing, are investigated. Both problems involve severe material deformation where the FEM has difficulties. In addition, the SPR process involves material separation that cannot be modeled by the available FE tools. The coupled FE/meshfree method provides engineers a new approach to address these difficulties. The efficiency and accuracy of the coupled finite element and meshfree simulation will be demonstrated on these problems with comparison to the best available approach in traditional FEM.

References

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[2] C. T. Wu and Yong G., "Development Of A Coupled Finite Element/Mesh-Free Method And Meshfree Shell Formulation," *GM R&D research report*, 2002.